MAGNESIAN MEGACRYSTS AND MATRIX IN THE MESOSIDERITE LAMONT

Joseph S. BOESENBERG[1], Jeremy S. DELANEY[2], and Martin PRINZ[1]
[1]Earth & Planetary Sciences, American Museum of Natural History, New York, NY 10024
[2]Dept of Geological Sciences, Rutgers University, New Brunswick, NJ 08903.

Introduction The Lamont mesosiderite was found in Kansas in 1995 and slabs of the meteorite contain abundant large (up to 2 cm) single crystals of olivine and pyroxene. The size and abundance of these megacrysts appear to be greater than that seen in other mesosiderites. The megacrysts, as well as similar but smaller mineral clasts, are set in the metal-rich plagioclase-POIK matrix [1] of the meteorite. Oxygen isotope ratios in bulk Lamont are typical of mesosiderites [2]. We determined size, abundance, chemical composition, mineralogic nature and origin of the megacrysts and related them to the matrix assemblage. Electron microprobe and SEM surveys of 106 large (>500µm) olivine (55) and pyroxene (51) megacrysts from slabs of Lamont were identified. The area surveyed is about 400 cm^2, the first large-scale survey of an individual mesosiderite, and megacrysts occupy 7.5% of the total area. Fifty-six megacrysts (28 olivine, 28 pyx) were analysed.

Olivine Megacrysts The olivine megacrysts surveyed range in size from 500µm to nearly 2 cm, and the smaller olivines range from 100-500µm. Olivine megacrysts are generally irregular in shape and always in contact with the fine- to medium-grained melt matrix of low-Ca pyroxene and plagioclase. Direct contact between metal in the melt matrix and olivine is rare. Individual olivine megacrysts are homogeneous, except near the 50-150µm edges, where Fe-enrichment often occurs. The cores of the 28 olivine megacrysts have a skewed and possibly bimodal distribution of Fo contents (Fig. 1). Most are about Fo_{90}, but range from Fo_{66-93}. The smaller olivine crystals are similar in composition to the more Fe-rich megacrysts, generally about Fo_{70}. Prominent coronas are not present around olivines, but necklaces of chromites enclose olivines and thinner necklaces are included within the olivines. The smaller olivine crystals are often embayed and surrounded by low-Ca pyroxene. Fe/Mn ratios of the olivine megacrysts cores range from 35-56, while the more Fe-rich rims have a slightly wider range of 30-66. The olivine is generally much more magnesian than typical mesosiderite olivine.

Pyroxene Megacrysts Pyroxene megacrysts similar in size to the olivines, 500 µm to 2 cm, are present, but smaller pyroxene crystals are scattered within the melt matrix. Core compositions of the pyroxene megacrysts range from Wo_1En_{83} to Wo_4En_{64}, with one crystal having a composition of Wo_5En_{53} (Fig. 2A). None of the pyroxene megacrysts are high-Ca pyroxene, and no high-Ca pyroxene has yet been found in Lamont. The pyroxene megacrysts are homogeneous, except for their outer edges which are enriched in Fe and Ca. A few pyroxene megacrysts have 50-100µm wide rims, which have Fe- and Ca-enrichment up to En_{53-60}. Matrix pyroxene is $Wo_{1-10}En_{53-83}$ and tends to be more Fe- and Ca-rich (Fig 2B). Smaller pyroxene crystals are often poikilitically enclosed in the plagioclase of the melt matrix.

Melt Matrix The melt matrix has a plagioclase-POIK texture as defined by other mesosiderites [1]. A 500 point mode of the melt matrix of a 4 cm^2 area, showed that by volume, Lamont has 42.7% low-Ca pyroxene, 16.9% plagioclase, 30.8% FeNi metal, 2.7% merrillite, 2.4% olivine, 2.2% troilite, 1.2% tridymite, and 1.0% chromite; ilmenite is present at the trace level. This area included some of the smaller megacrysts of olivine and low-Ca pyroxene. A recalculated mode (metal-troilite-free), excluding the olivine megacrysts, is 66.1% low-Ca pyroxene, 26.2% plagioclase, 4.2% merrilite, 1.9% tridymite, 1.5% chromite. The actual low-Ca pyroxene abundance is lower since smaller low-Ca pyroxene megacrysts were included in the mode. Comparison of Lamont to other modal data taken from [1,3] show that Lamont has lower pyroxene and higher plagioclase abundances than in other plagioclase-POIK mesosiderites (Bondoc, Budulan, Mincy, Veramin); merrilite abundances are among the highest. Melt matrix pyroxene composition is noted above and melt matrix plagioclase is An_{96-92}. No component in Lamont is eucritic and the matrix pyroxene compositions have only limited overlap with the cumulate eucrite range.

Discussion Comparison of Lamont and literature data [4,5] shows that Lamont contains the most magnesian olivines of the known mesosiderites, although a few grains from Hainholz are similar. Olivine Fo contents in howardites are generally lower [6] but Bununu, Kapoeta, and Molteno have significant populations of high magnesian olivine. Main group pallasites also have olivine compositions that are near Fo_{90}, but their Fe/Mn ratios are too low to allow for common petrogenesis. The absence of high-Ca pyroxene and abundance of merrilite is noteworthy since high-Ca pyroxene is thought to be the major Ca source for redox formation of merrilite [7]. However, complete exhaustion of high-Ca pyroxene through reaction with phosphorus from the metal seems reasonable. Alternately, Ca from matrix pigeonite may supply a source of Ca for the reaction.

Three possibilities exist to account for textural and compositional ranges of the silicates in Lamont. (1) Lamont silicates may represent Mg-rich olivine pyroxenites that were mixed with a eucritic fraction at temperatures high enough to melt the eucritic clasts to produce the mafic matrix. The magnesian compositions of the mafic matrix would be the result of Fe-Mg exchange between the olivine pyroxenite and the eucritic melt. However, the presence of unaltered Fo_{90} olivines and magnesian pyroxenes, the absence of large reaction rims or coronas on olivine, the lack of overgrowths on pyroxenes, and the minimal redox effects seen in the silicates (high Fe/Mn ratios), seem to be in conflict with this mesosiderite reworking model. (2) The megacrysts may represent a high temperature residue remaining after the extraction of mafic material. The composition of the olivines and lack of mafic lithic clasts suggests that if the megacrysts formed as a residue, they must have equilibrated at temperatures high enough for total melting of any mafic component. The plagiolase-POIK texture of the matrix could subsequently form by mixing a magnesian mafic component into the olivine pyroxenite sequence during the metal-silicate mixing event. It is unlikely that any known chondritic precursor could have been partially melted to produce the very magnesian megacryst assemblages. (3) The magnesian megacrysts and the plagioclase-POIK matrix may represent a monotonic crystal fractionation sequence. Partitioning calculations indicate that megacrystic olivines and pyroxenes did not equilibrate with a melt of the same composition as the matrix mafic assemblage. The range of mg#'s in olivine are much more compatible with progressive crystallization of first Mg-olivine, then olivine+pyroxene, then finally, the observed mafic matrix. The magnesian olivine (Fo_{93}, Fe/Mn~40) of Lamont requires a melt composition of mg# = 80, Fe/Mn=27. Equilibrium pyroxenes produced from such a liquid would be En_{93}, Fe/Mn=24, more magnesian than pyroxene composition seen in any mesosiderite. However, fractionation of ~65% olivine from such a melt, could enrich the melt in SiO_2 and decrease the mg# to ~62, Fe/Mn=28. Pyroxene fractionation would start at compositions of En_{83}, Fe/Mn=29 (as seen in the pyroxene megacrysts) and progress through the observed range of pyroxenes to ~En_{68}. The mafic plagioclase-POIK-textured matrix could be the final Al-rich end member of the fractionation series.

In general, there is no evidence for the reduction of Fe from the Lamont silicates. Thus, Fe/Mg ratios of the silicates reflect their igneous history rather than a later mesosiderite history. The system from which the Lamont silicates formed is, however, more magnesian than that of most other mesosiderites and may present clearer insights into their evolution.

References [1] Hewins, R.H. (1984) Proc. Lunar. Planet. Sci. Conf 15th, JGR, 89 C289-C297; [2] Clayton, R.N. (1996) GCA 60, 1999-2017; [3] Prinz, M. *et al*. (1980) Proc. Lunar. Planet. Sci. Conf 11th, 1055-1071;[4] Nehru, C.E. *et al.* (1980) GCA 44, 1103-1118; [5] Delaney, J.S. *et al*. (1980) Proc. Lunar. Planet. Sci. Conf 11th, 1073-1087; [6] Desnoyers, C. (1982) GCA 46, 667-680; [7] Harlow, G.E. *et al*. (1982) GCA 46, 339-348.

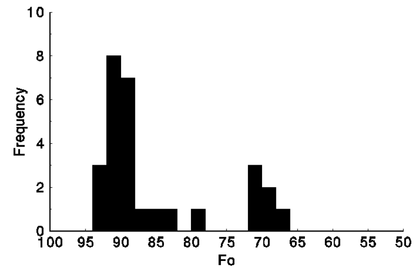

Fig. 1 Core Compositions of Olivine Megacrysts

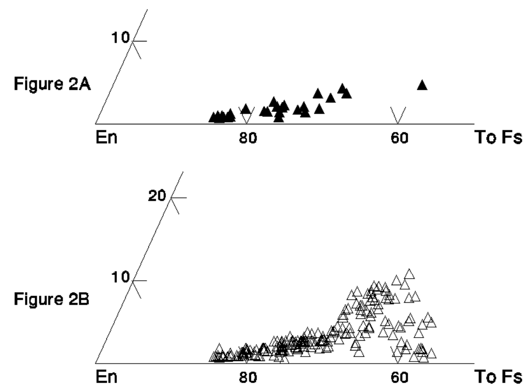

Fig 2. (A) Core Compositions of Pyroxene Megacrysts (B) Pyroxene Compositions of Mafic Melt Matrix